Available online at www.sciencedirect.com
ScienceDirect
Renewable and Sustainable Energy Reviews
11 (2007) 467–481
RENEWABLE
& SUSTAINABLE
ENERGY REVIEWS
www.elsevier.com/locate/rser

The current situation of wind energy in Spain

Germán Martínez Montes*, Enrique Prados Martín, Javier Ordóñez García

Ingeniero de Caminos, Canales y Puertos, ETS de Ingenieros de Caminos, Universidad de Granada, Proyectos de Ingeniería, Departamento de Ingeniería Civil, 18071 Granada, Spain

Received 17 March 2005; accepted 18 March 2005

Abstract

Successive international commitments relating to energy and climatic change (embodied in the Kyoto Protocol) and the need to rationalise the sources of generated energy, have meant that renewable energies have started to gain a great deal of importance within the worldwide energy network. In the case of Wind Energy, and in terms of production, Spain is the second most important country at European level and the third most important country at global level. Spain holds these positions as a result of the establishment of a stable regulatory framework, better understanding of the resource and improved technology that have afforded considerable cost reduction in terms of initial investment, maintenance and exploitation. This article focuses on these circumstances in view of their relevance at international level, which is due to the highly feasible possibility of exporting Spain's experiences to other countries with guarantees of success.

Keywords: Renewable energy; Wind power; Energy policy

Contents

*Corresponding author. Tel.: +958 24 94 40; fax: +958 24 61 38.
E-mail address: german00@ugr.es (G.M. Montes).

1364-0321/$ - see front matter
doi:10.1016/j.rser.2005.03.002

1. Introduction

The energy sector represents an essential and dynamic part of a country's economic activity. Therefore, supplying energy under the safest conditions whilst offering the highest quality and the lowest costs is a vital objective within any energy policy [1].

Thus, energy generators must adhere to the criteria of rationality, efficiency and ensuring supply. Moreover, the national energy network must be able to reconcile private initiatives and its nature as a public service, with a view to achieving a reliable and efficient service.

Over the last few years, the processes of energy deregulation that have been set in motion in developed countries, including Spain, are producing significant changes within the energy sector.

It should also be pointed out that the demand for energy continues to grow and its evolution is not solely dependent on a country's economic activity and climatic conditions, but rather is also influenced by the trend of having to meet a greater number of demands.

2. An overview of Europe

These circumstances and objectives are reflected in the Council of Europe's Directive 96/92/EC [2] concerning the internal electricity market, which seeks to: ensure energy supply, the quality of this supply and the lowest possible prices; establish and maintain competitiveness amongst European traders within the energy sector; and protect the environment. In addition, it states that electrical energy must be supplied on a renewable basis via the appropriate regulations that give preference to these types of installations.

The environmental impact of electricity that is generated via conventional energy sources already represented a priority for all the countries that signed the Kyoto Protocol [3]. At European level, renewable energies officially began to be integrated with the publication of the European Commission's Green Paper [4] and White Paper [5].

The objective of the EU's White Paper on Renewable Energies is to ensure that 12% of the energy consumed in Europe is supplied via renewable energies by 2010. When it comes to wind energy, this means increasing Europe's installed capacity from 3.5 GW in 1996 to 40 GW in 2010 throughout the entire EU. This wind energy capacity increase of 36.5 GW involves an associated investment of around 271 thousand million euros [6].

The Paper was issued by the European Commission in November 1997 with the aim of presenting a Community strategy and a plan of action to promote renewable energies within the European Union. Since the publication of the White Paper, the European Commission has set a series of initiatives in motion with the aim of establishing a European framework for the promotion and development of renewable energies.

Directive 2001/77/EC [7], which was passed in September 2001, set the objectives in relation to the electricity generated via renewable energy sources within the internal electricity market.

Moreover, it should also be borne in mind that the European Constitution will include a Chapter that deals with energy, which will, for the first time at the level of a European Treaty, 'promote energy efficiency and saving and the development of new and renewable forms of energy' as objectives of the European policy on energy.

Energy is defined in the new Constitution as a 'shared competence' of the Union and the Member States, as is the case with other areas such as agriculture and the environment (Article I-13).

"In establishing an internal market and with regard for the need to preserve and improve the environment," the European Constitution specifically states that "Union policy on energy shall aim to promote energy efficiency and the development of new and renewable forms of energy" (Article III-157 paragraph 1, letter c).

"Without prejudice to the application of other provisions of the Constitution", the aforementioned objectives of the Union's energy policy will be achieved via "measures enacted in European laws or framework laws" (Article III-157 paragraph 2.1) The passing of each type of legislative act will be subject to two principles established by the Constitution, for the first time, at a general level:

- The principle of joint decision-making between the European Parliament and the Council of Ministers.
- The principle of decision-making via a qualified majority of the Council of Ministers. This point is extremely important given that decision-making via unanimous vote would have led the Union to deadlock.

3. An overview of Spain

In response to the new determinants of the sector, the Spanish energy policy seeks to incorporate the environmental aspects of energy and this is also the objective of Law 54/1997 concerning the Electricity Sector [8].

The Plan to Promote Renewable Energies (PLAFER), passed by the Cabinet on December 30, 1999, represents the materialisation of the compromise undertaken in Law 54/97.

On the basis of an analysis of the general context of energy and its prospects for evolution, and of the current situation of renewable energies (and an assessment of the additional capacity of available resources for these energies within the country, along with the requirements for their development) the objectives of the Plan to Promote Renewable Energies have been established for 2010.

In addition, with the aim of promoting the use of renewable energy sources and obtaining greater energy efficiency, various programs have been set in motion and several institutions have been set up at national level.

Thus, the main objectives of the Research Centre for Energy, the Environment and Technology (CIEMAT)[1] involve providing solutions to improve the use of resources and energy generation systems, developing alternative energy sources and solving the problems of Spanish companies in relation to energy and its repercussion on the environment.

[1]Public research and technological development body dependent on The Treasury through the Secretary of State for Energy, Industrial Development and Small and Medium-sized Businesses. Initiated in accordance with Royal Decree 802/1986 and subsequently modified by Royal Decree 252/1997 of 21/02/97.

The Institute for Energy Saving and Diversification (IDAE)[2] is mainly concerned with promoting energy efficiency and rational energy use in Spain, in addition to the diversification of energy sources and renewable energies.

The Renewable Energy Sources Producers Association (APPA) is made up of more than two hundred small and medium-sized companies that generate electricity from renewable energy sources. It was created in 1987, and is the only association at state-level that has representation in the Consultative Board for Electricity of the National Energy Commission (CNE), the body charged with regulating energy networks.

3.1. Plan to promote renewable energies

The importance of the substantial increase of renewable energy sources for Spain and the European Union, and the significantly higher number of consumers whose demand for energy is met by these sources, has, within the framework of energy policy at national and Community levels, led to the devising of the Plan to Promote Renewable Energies by 2010.

The Plan sets ambitious development objectives so that, in accordance with the Laws regulating the Electricity Sector, renewable energy sources cover at least 12% of the total demand for energy in Spain by 2010, which is the same objective that has been globally applied to the European Union in the White Paper on Renewable Energies issued by the European Commission.

This common objective, which in relative terms implies doubling the current use of renewable energy in Spain (6.3% of primary energy consumption in 1998, or rather 6.2% if we take the hydrologic year, wind year and solar year into consideration), represents a lot more:

Firstly, doubling the use of these sources, within the context of increasing energy demand, implies multiplying the amount that must be met by renewable energies by more than two.

Secondly, the majority of the energy that is currently supplied by renewable sources takes the form of electricity that is generated via water or biomass (around 95% was produced by these sources in 1998). Water-power presents limited scope for development, whilst energy produced by biomass needs to incorporate new techniques, in terms of the use and harvesting of resources, in order to reach the required production levels. In parallel, other areas that, to a greater or lesser extent, have a limited participation, or are practically inexistent within the Spanish energy framework, must be strongly encouraged.

It should also be pointed out that the objectives of the Plan are linked to energy saving criteria wherein the effects of the most active energy efficiency and environmental protection policies have been incorporated, which, in view of current tendencies, is necessary in order to achieve the significant reduction of consumption envisaged by the Plan. However, the consumption envisaged by the Plan—around 135 million toe by 2010—creates the need for an additional effort in order to meet the objectives of increasing renewable energies at levels that are higher than was previously foreseen.

To a large extent, the success of the Plan depends on correctly defining and adapting the objectives and on the capacity of the different administrations (General State

[2]Semi-public commercial entity. As of July 26, 2002 and in accordance with Royal Decree 777/2002 it is dependent on The Treasury through the State Secretary for Energy, Industrial Development and Small and Medium-sized Businesses.

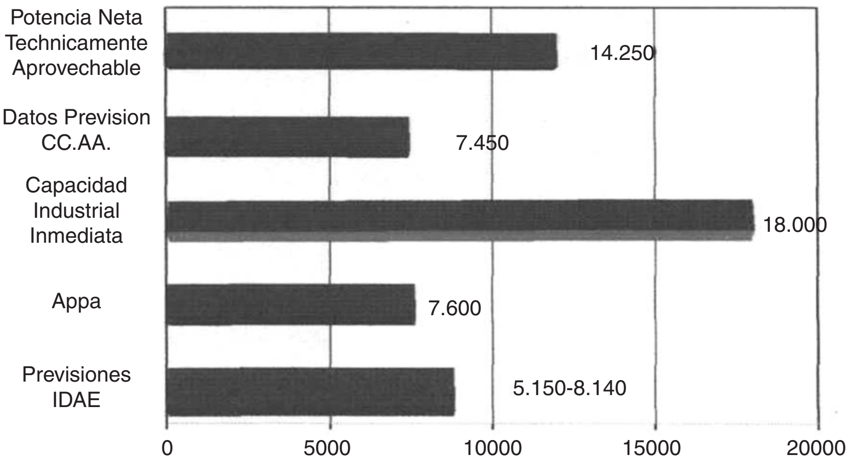


Fig. 1. Energy (MW) that will be produced within the period covered by the plan.

Administration, Regional Administration and Local Administration) to coordinate and incorporate the necessary measures within their respective areas in order to develop the Plan.

Analysis of the Plan allows us to reach the following conclusions:

- Current estimates place the net energy that is technically usable at 15,100 MW.
- The wind-driven generator industry is capable of constructing generators, within the period covered by the Plan, which would produce around 18,000 MW.
- The Autonomous Regions have set objectives within the period covered by the Plan (1999–2010) that involve around 7450 MW.
- The Renewable Energy Sources Producers Association (APPA) has estimated an installed capacity of around 7600 MW before the end of 2010.
- IDAE has envisaged two hypothetical situations: the first, termed Current Policy, presupposes a negative social perception with regards to wind energy, and estimates an installed capacity of 5150 MW; the second scenario, Active Promotion, approaches the subject under the assumption that current barriers will be broken down before 2001, with results that show an installed capacity of 8140 MW that will be produced within the period covered by the plan (Fig. 1).

3.2. Electricity market

The control and management of the operation of the Spanish electricity network is regulated by Law 54/1997 concerning the Electricity Sector and by Royal Decree 2019/1997 [9], which deals with the organisation and regulation of the electricity production market. This Royal Decree establishes a separation between the economic and technical management of the market, which are the responsibility of the Market Operator (OMEL) and the Network Operator (REE), respectively.

The duties of the REE within the Spanish electricity network revolve around controlling and operating the network in real time, ensuring that the generation of the electric power

stations and energy transfer is correctly coordinated, whilst guaranteeing that the electricity is supplied safely and constantly. The OMEL is responsible for economic management: managing the system of offers to purchase and sell energy that are made by the various agents within the production market and subsequently arranging the corresponding settlement [10].

In Spain, the most significant consequences of Law 54/1997 involve the introduction of competition in the areas of generation and marketing, the progressive vertical disintegration of the sector, the emergence of an electricity market that is governed by the principles of competition and the progressive liberalisation of consumption [11,12].

Four large companies (Endesa, Iberdrola, Unión FENOSA, Hidroeléctrica del Cantábrico) control production and, through affiliate companies, also participate in distribution and marketing and maintain important economic links both within and outside the sector. Thus, they have real power to influence the evolution of prices.

3.3. Special regime

The Law concerning the Electricity Sector has provided the greatest support for the development of wind energy. It should be borne in mind that policies that seek to incorporate these types of energy into the electrical energy network always involve difficulties [13]. As a result of this Law, those producing electricity via wind energy with a capacity of less than 50 MW may incorporate the electricity they produce into the electricity network without the need of entering the system of offers and will receive a subsidy based on the offer price with the aim of ensuring a reasonable rate of return whilst reaping the environmental benefits that the use of this type of energy entails [14].

Royal Decree 2818/1998 [15] of December 23, which develops the aforementioned law, established the requirements and procedures involved when opting for the special regime, the procedures for registering in the corresponding registry, the conditions under which energy is transferred and the economic regime.

The flexible price policy established in this decree, involving a choice between a fixed price or 'market price + subsidy', is proving to be a determining factor in the attainment of the wind energy objectives proposed in the PLAFER as it has created an environment that encourages investors.

In fact, it should be highlighted that at European level, only those countries that have developed policies to encourage the development of renewable energies (in other words, Germany, Denmark and Spain) have shown an increase of installed wind energy capacity [16,17] and are serving as a model for other countries that have recently set initiatives in motion that will allow them to take advantage of their wind energy capacity [18].

3.4. The new decree, R.D. 436/2002 and its possible reform

Finally, reference must be made to the most recent development in the sector that takes the form of the passing of Royal Decree 436/2004 [19], concerning the prices applicable to the Special Regime, which was passed on March 27 as a substitute for Royal Decree 2818/1998.

This decree was established as an attempt to achieve stability within the sector; however, many analysts feel that the Law concerning the Electricity Sector of 1997 and its subsequent development in R.D. 2818/98 represented the key to the increase of installed

wind energy and therefore should merely have been perfected rather than substantially modified, as it has been in the new regulation.

The new Royal Decree undoubtedly includes a positive point that involves linking the evolution of the price of renewables to the TMR [reference tariff fixed on the basis of the average initial costs]. However, the new regulations have a clear objective: to force promoters to enter the market under the same conditions that are applied under the Ordinary Regime. In the opinion of principal actors such as APPA this has been has involved a certain degree of hurriedness [20]. Although an incentive to enter the market has been included, the majority of promoters will encounter a lot of difficulties with this option given the high costs of deviations in the production forecasts, which particularly affects wind energy.

On the other hand, the new decree maintains a fixed price or regulated tariff system, but incorporating a year-based scale, according to the technology, of 90, 85 and 80% of the TMR calculated on a retroactive basis, and also introduces the payment of deviations, although with a margin of 20% in the case of wind energy and of only 5% in the case of small-scale hydroelectric schemes. Whilst representing a considerable reduction, this method may afford a price platform with a foreseeable evolution, and, in principle, has been warmly welcomed by financial institutions.

The most controversial aspect of the new decree, which to many represents a contravention of Law 54/97, involves the elimination of the hourly pool purchase price with subsidy which affects the vast majority of producers (almost all the producers in the case of wind energy) and which has been substituted by the price of the last offer + subsidy + incentives, with penalties for deviations.

Table 1 compares the prices for a typical wind energy plant according to the old decree and the current decree.

Moreover, the transitional period that has been established for installations where R.D. 2818/98 has been applied (up to January 1, 2007) contains a very serious modification in the form of an obligation to pay deviations as of January 1, 2006. Therefore, we are not dealing with transition in the strict sense, but rather a derivation that involves new and extremely serious conditions for the promoter.

Promoters of renewable energies have lost no time in presenting initiatives and in recent months the APPA has held intense discussions with the Administration in order to modify the most problematic points of R.D. 436/2004 and has also filed an appeal [recurso contencioso-administrativo] against the State with regards to those aspects of the decree which, in its opinion, violate the Law concerning the Electricity Sector.

The latest reports in this regard suggest that the new heads of Administration are willing to modify R.D. 436/2004, although the scope of these modifications has not been specified, and it is hoped that the modification will be made in the near future (January or February, 2005).

Apart from the new price system, the analysis of the current situation of the wind energy sector will soon be affected by the section of the new decree concerning connections, which may prove to have as much or greater influence than the regulations affecting the tariff system. A matter that needed to be addressed for the last several years, the new regulation that regulates this key process within our activity may represent, from a negative point of view, a barrier that will block hundreds of projects, or, from a positive point of view, the opportunity to introduce, once and for all, objective, clear and transparent criteria with regards the relationship between promoters and the companies who are the title-holders of the transport and distribution networks.

Table 1
Comparative of the prices for a typical wind energy plant according to the old decree and the current decree

Metodología tárifas eléctricas del régimen especial					
Eólica	R.D. 2818/1998, Precio variable[a]	R.D. 436/2004			
		Precio fijo			Mercado
		90% T.M.R[b]	85% T.M.R[b]	80% T.M.R[b]	
Precio final horario	37.2	64.8648	61.2612	57.6576	30.0
Prima	27.5				28.8
Incentivo					7.2
Garantía de potencia[c]					5.5
Subtotal	64.7	64.8648	61.2612	57.6576	71.5360
C.reactiva	2.3[d]	2.52[e]	2.52[e]	2.52[e]	2.52[e]
Costes desvíos	−2.16[f]	−2.16[f]	−2.16[f]	−2.16[f]	−1.05[g]
Coste servicio predicción[h]	−0.3	−0.3	−0.3	−0.3	−0.3
Coste agente comercializador					−1.0
Total	64.5400	64.9248	61.3212	57.7176	71.7060
C. huecos de tensión[i]	3.6036	3.6036	3.6036	3.6036	3.6036

[a]Dispondrán de un período transitorio hasta el 01/01/2007.
[b]T.M.R.: 72.072 €/MWh.
[c]Media histórica de los 2 últimos años (2.75 €/MWh) + Coef. Reparto (2.75 €/MWh) para un parque de 3000 h.
[d]Estimación del 3.55% del Precio Medio Final Horario + Prima.
[e]Estimación s/3.5% T.M.R. (Falta Coste).
[f]Estimación para una instalación de 2500 h. y un desvío del 30%.
[g]Para un desvío del 35%.
[h]Parque de 25 MW, 2500 h. y tres años de coste.
[i]Sólo los 4 primeros años. Coste inversión.

In the same line, the new decree should clearly and unequivocally give expression to the priority given to renewable energies in terms of network access, which is recognised in our legislation and which is compulsory as a result of the implementation of the Directive within each Member State, both in terms of energy transfer and connections to the network. This does not mean the including official recognition (this has already been achieved), but rather specifying practical, feasible and precise formulae in order to make this a day-to-day reality in the dealings between promoters and distribution companies.

An analysis of the current situation shows that priority in terms of network access is currently given to gas power stations, the so-called combined cycle stations. These stations are clearly a key element in the future of Spanish electricity generation, but their privileged position—in terms of infrastructures and connection facility—in comparison with renewable energies represents an affront.

In terms of installed capacity by the end of the decade, attention should be drawn to the difference between the objectives set by the autonomous regions and those set by Central Government, which coincide with the objectives that were set by ‘Red Eléctrica’ [Electricity Network] in a document that established the limit of the wind energy that could be taken on by the network. From the outset, it must be borne in mind that the figures used by the system operator were based on technical criteria that are now recognised as being obsolete. However, the main point is that the energy planned to be installed by the autonomous

regions by 2010–2011 involves 20,000 MW, whilst we continue to talk about the famous 13,000 MW.

Many, such as APPA, believe that the sector is perfectly capable of achieving the objectives set by the autonomous regions in terms of wind resources, financial backing and, of course, the expertise of the promoters. The bottleneck occurs at the point of network connection and this new decree may alleviate or aggravate the problem.

Nor must we forget the increasingly more problematic stage of administrative processing, in particular when it comes to environmental questions where we are still faced with a situation wherein no objective criteria have been established that would allow promoters to know, a priori, what is expected of them.

4. The current situation of wind energy in Spain

Significant technological advances are being made in the area of wind energy [21]. At the end of 2003 the installed capacity on a worldwide scale represented more than 39,500 MW [22]. Europe contributed around 75% of this capacity. Apart from Europe only the US, with a capacity of 6375 MW and India, with 2125 MW displayed significant figures [23] (Fig. 2).

Spain, as a result of the increase in the installed capacity over recent years, is second only to Germany in terms of installed capacity. Germany continues to lead both Europe and the world with 14,610 MW of installed capacity, in front of Spain and Denmark (3110 MW), which, having abandoned the fixed price system is practically at a standstill (Fig. 3).

Several factors have played a part in making wind energy what it is today:

- Stable regulatory framework governing electricity generation that permits windfarms to have a reasonable return.

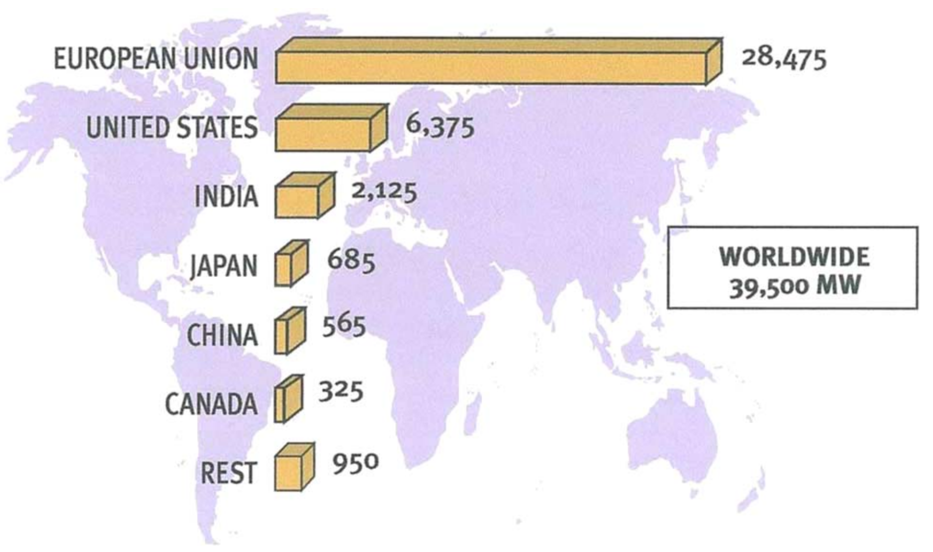


Fig. 2. The installed wind capacity on a worldwide scale (MW) at the end of 2003.

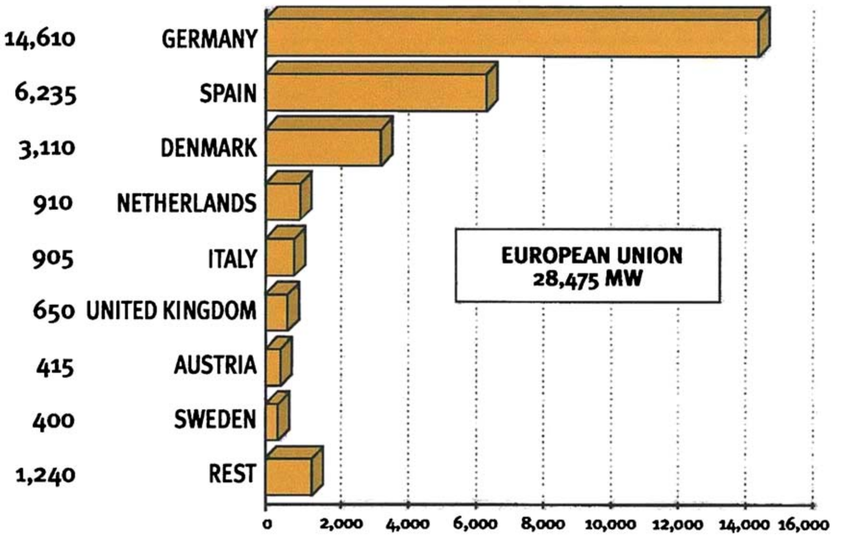


Fig. 3. The installed wind capacity in European unio (MW) at the end of 2003.

- Regulations in several autonomous regions governing the procedures to authorise the installation of wind energy.
- Better understanding of wind as a resource.
- Improved technology and mass production.
- Lower investment and exploitation costs and improvements within the financial framework.

The evolution of the installed capacity of wind energy in Spain is shown in Fig. 4:

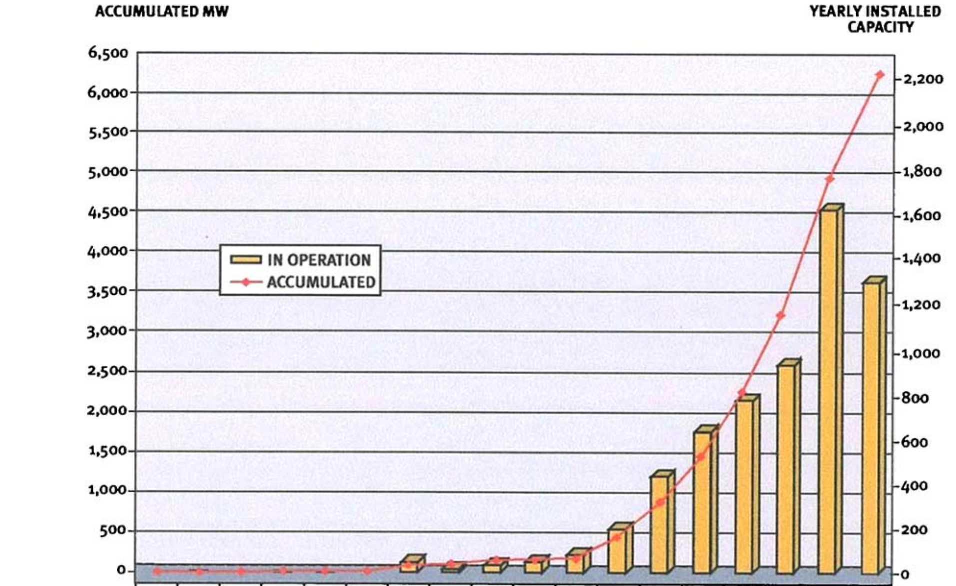
Fig. 5 charts the annual investments:

The installed capacity has grown at a spectacular rate over the last 10 years, with a small drop in 2001. With regards to the PLAFER objectives, which set figures of an additional 8149 MW of installed capacity by 2010—60% by 2006 (in 2001 50% of the energy objectives set for 2006 had already been met)—the objectives will be met without any problems.

However, there is still a lot to do if we are to meet the objective set in the Plan de Infraestructuras Eléctricas y Gasísticas [Plan of Electrical and Gas Installations] passed by the Government in 2002, which sets a figure of 13,000 MW of installed capacity by 2011 [24]. Any delay or sudden stop in the development process would prevent us from achieving this objective, which will involve the need to install 1000 MW of capacity per year, thereby maintaining current trends. This is reflected in Fig. 6:

In terms of development in the autonomous regions, Galicia leads the field, and is far in front of Castilla La Mancha, Aragon, Navarre and Castilla Leon. The remaining autonomous regions fall some way behind this group of front runners.

The Cantabrian, eastern and south-eastern coasts possess significant resources. Castilla Leon and La Rioja have started to produce wind energy and the north-eastern area of Soria bears mention for its capacity. In Castilla la Mancha, in the province of



	86	87	88	89	90	91	92	93	94	95	96	97	98	99	00	01	02	03
IN OPERATION	0.4	1.2	0.8	1.5	2.7	0.7	38	6.0	24	40	96	229	393	642	815	985	1,615	1,344
ACCUMULATED	0.4	1.6	2.4	3.9	6.6	7.3	46	52	75	115	211	440	834	1,476	2,292	3,276	4,891	6,235

Fig. 4. The evolution of the installed capacity of wind energy in Spain.

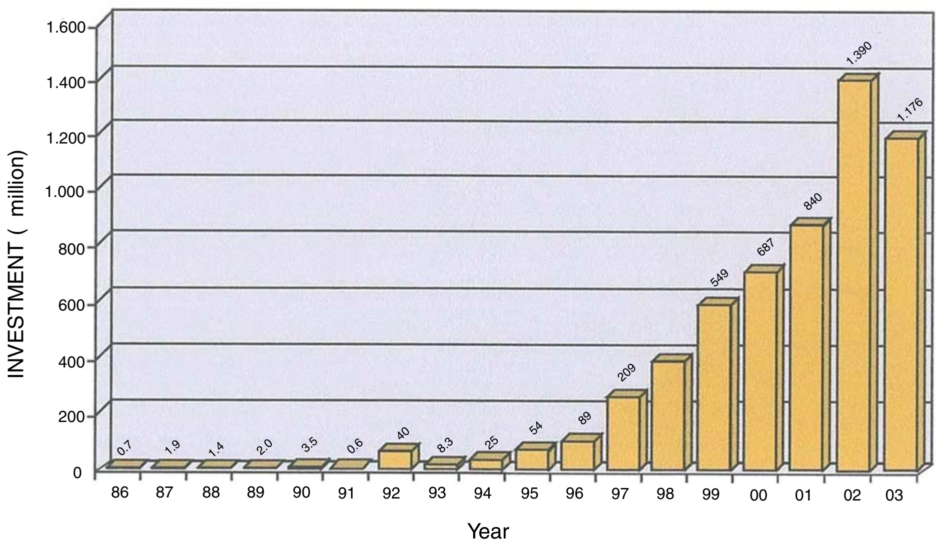


Fig. 5. Annual investments in wind energy sector in Spain.

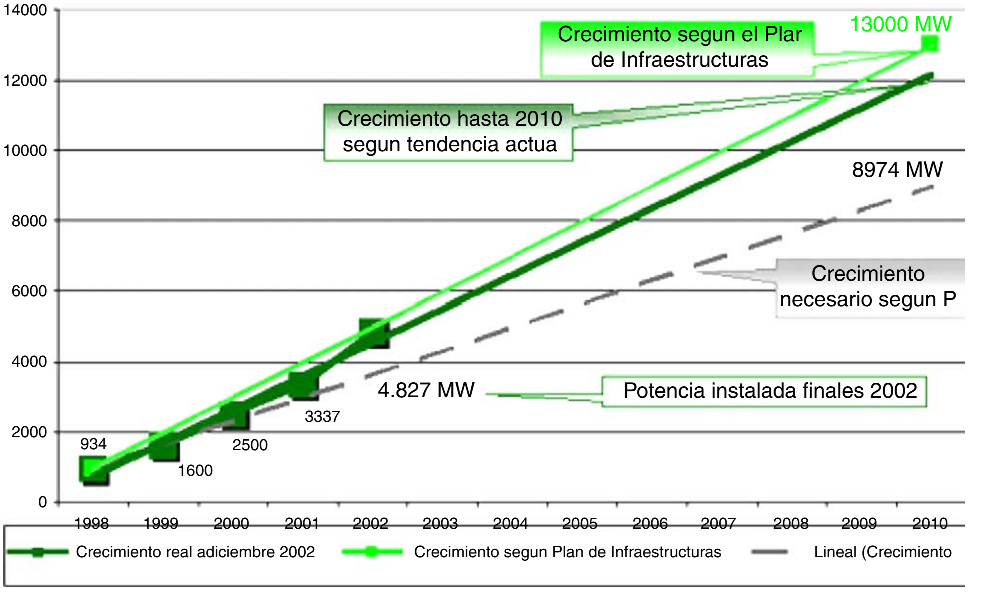


Fig. 6. Real and planning grown comparation.

Albacete, intense research is taking place in terms of wind measurement. The north of Extramadura also appears to possess sufficient resources to permit the exploitation of its winds.

Analysing the figures for 2003, we can see that, in terms of windfarms, Galicia leads the field for the third consecutive year with an increase of 264 MW, whilst Castilla La Mancha has, for the first time, surpassed the goal of 1000 MW, with an increase of 269 MW in 2003 that allows it to maintain second place.

Other noteworthy points in relation to the autonomous regions are outlined below:

- Castilla Leon is the Autonomous Region wherein the highest capacity of wind energy was installed in 2003 (289 MW).
- Aragon increased its wind energy capacity by 261 MW, maintaining third place and almost surpassing the goal of 1000 MW.
- Navarre increased its wind energy capacity by 26 MW.
- La Rioja is still in sixth place with a total capacity of 272 MW, of which 69 MW were installed in 2003.
- Andalusia increased its windfarms and produced an additional 70 MW.
- The Basque Country has multiplied its installed capacity by three, setting up two new windfarms.
- Asturias increased its installed capacity by almost 48 MW in 2003, which are the result of a new plant.
- Murcia has also multiplied its installed wind energy capacity by almost three.
- The installed wind energy capacity in the Canary Islands, Catalonia and the Autonomous Region of Valencia has not changed since 2002.

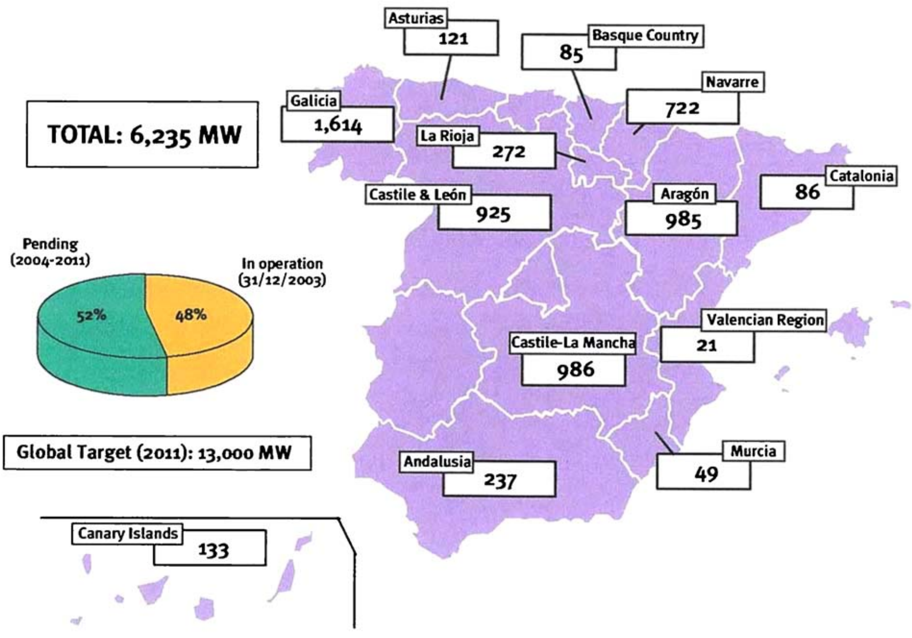


Fig. 7. The installed capacity of the autonomous regions of Spain in December 2003.

- The Balearic Islands maintain their token contribution to wind energy with a capacity of slightly less than half a MW (0.459 MW).

Fig. 7 shows the installed capacity of the Autonomous Regions in December 2003. It should also be pointed out that the business framework is made up of more than 170 companies that include manufacturers (wind turbines, blades, towers, generators, multipliers, electrical equipment, etc.), suppliers (hydraulic and electrical equipment and equipment for controlling and regulating), mechanical construction and public works companies, installation companies and maintenance, exploitation and engineering companies.

The national wind energy industry has started to export its wind generators. Several contracts have been allocated for the construction of windfarms in China, India, and Mexico and in Cuba, where work began in 1998. In addition, contracts are at an advanced stage with Portugal, Turkey, Tunisia, Egypt, Brazil and Argentina. Fig. 8 shows the breakdown of companies in terms of the installed wind energy capacity in Spain.

Another detail that bears mentioning is the fact that the average capacity of the wind generators that were installed in 2003 showed a slight increase, and reached the figure of 844 Kw (808 in 2002).

In conclusion, wind energy is one of the few technologies of the future wherein Spain leads the field, and therefore we must take the necessary steps to ensure that this remains to be the case, respecting the initial motivations, the rights of all agents within the sector and applying legislation with conviction.

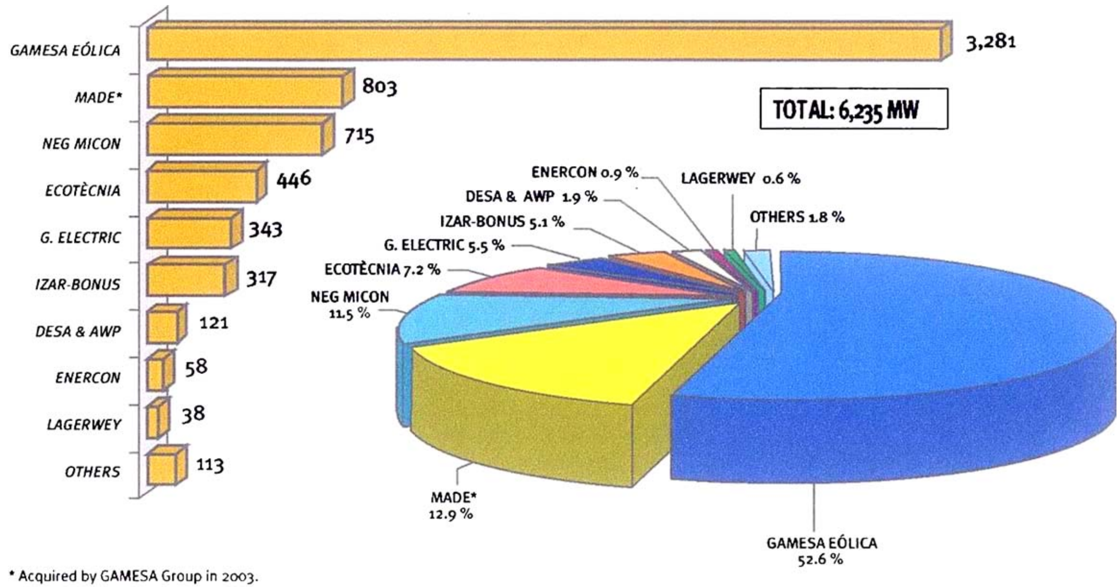


Fig. 8. Breakdown of companies in terms of the installed wind energy capacity in Spain.

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